Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Modifications of the Commission's Rules for	)	ET Docket No. 03-201
Unlicensed Devices and Equipment Approval.	)	
Sec 15.212 Modular Transmitters	)	
	)	
	)	

INTRODUCTION

JC-61 the JEDEC Committee 61 on digital interfaces for communication systems (the "JC-61") in JEDEC[1] hereby respectfully offers its Comments on the Notice of Proposed Rulemaking (the "NPRM") in the above-captioned Proceeding.[2] JC-61 Committee: Advancing Wireless Technology, as a leading consensus-based industry standards body, produces **digital interface standards** for wireless networking devices, including wireless local area networks ("WLANs"). This document was prepared and approved by the JC-61 Committee. JC-61 Committee and the referenced working groups are interested parties in this Proceeding and we appreciate the opportunity to provide these comments to the Commission.

1. JC-61 Committee commends the Commission for adopting the NPRM, proposing a new class of "partitioned" modular devices with two basic components: the **radio front-end** and the **digital radio controller**. We believe that this is a positive trend for the industry. In Appendix A, we describe potential scenarios on how the "partitioned" modular devices will emerge.
2. We note that all of the comments filed in this proceeding generally support the Commission's proposals on partition modules, with specific comments regarding **Paragraphs 33, 36, 37, 40, and 41.**

[1] JEDEC – 'Joint Electron Device Engineering Council' is the semiconductor engineering standardization body of the Electronic Industries Alliance (EIA), a trade association that represents all areas of the electronics industry. The JC-61 is one of it's 48 committees focusing on creating standards for interfacing multiple components such as radios and back-end device, and upper and lower MAC.

[2] This document represents the views of the JC-61 and the referenced working groups. It does not necessarily represent the views of the JEDEC as a whole or the JEDEC Standards Association as a whole.

NPRM PARAGRAPH 33 STATES:

"*A new class of "partitioned" modular devices is now under development. These transmitters consist of two basic components: the "radio front end," or radio elements and the "firmware" or specific hardware on which the software that controls the radio operation resides. The radio front end and firmware can each be self-contained units. The radio front end is generally a stand-alone unit while the firmware may either be a stand-alone unit or may be collocated within a device on a host system. A further partitioning is also possible by removing the local oscillator and tuning capacitors the antenna from the radio front end. The separation of modular units into these even smaller components will provide manufacturers the flexibility to design a larger variety of modular systems by mixing and matching individual components.*"

3. We note that the term "firmware" has multiple meanings in industrial applications and thus can be confusing. Furthermore, there are implementations of transmitter control functionality that do not use firmware under any meanings of this term, and there are significant portions of existing firmware that have no influence upon the RF emissions of the module. These concepts are represented by the implementation architectures depicted in Appendix A. We suggest replacing the term "firmware" with "digital radio controller". The "digital radio controller" includes the digital control and signal processing functions external to the radio front-end component that control radio operation over a digital interface. The digital radio controller may be implemented with hardware, firmware, or a combination thereof, and may include elements that are able to affect the power or spectral characteristics of the RF output.

NPRM PARAGRAPH 36 STATES:

"We re-iterate that the requirements above are particular to modular transmitters in which all components are housed within a single enclosure. We propose to modify requirements 1, 2, and 5 in order to accommodate the special case of new partitioned modules in which the antenna, radio front end, and firmware are independent of one another."

4. We recommend that the term "firmware" be replaced with a different term, perhaps "digital radio controller" as described in the comments for paragraph 33. We would suggest that this change be applied in all those places where firmware is used below.

NPRM PARAGRAPH 37 STATES:

"Requirement #1. We propose to clarify that only the radio front end of a partitioned modular unit must be shielded. All components that require shielding would be required to be inside this unit. The other sections of the modular unit, the firmware that will be either part of another device or sit "stand-alone" on a platform and an antenna to complete the system, would not required to be shielded. We would also provide that the physical crystal and tuning capacitors can be located external of the shielded radio front end."

5. We suggest that any external crystal and tuning capacitor should be specified by the manufacturer in the requirements instructions (paragraph 35.7) for use of the module submitted.

Instances of the module that are intended to use the certification must use components (e.g. external crystals, tuning capacitors) that fully meet the radio front end module supplier's requirements for acceptable substitution as stated at the time of original reference design certification.

NPRM PARAGRAPH 38 STATES:

"regarding alternative methods of demonstrating compliance with the FCC rules, including: a) impulse interference testing similar to that used in EN61000-4-4; b) using a two-tone interference test and coupling the interferers into the cabling; and c) looking at interference levels required to degrade the bit error rate of the interference to an unacceptable level, (i.e., typical interface bit error rates of 10^{-11}, degraded to 10^{-6})."

6. The same paragraph suggests that the interface must be digital with a signaling amplitude of at least 150 mV peak-to-peak. We offer the following suggestions and comments:

7. We agree that the interface between the radio front end and the digital radio controller sections of the modular system must be digital with a minimum signaling amplitude of 150 mV peak-to-peak. We note that such an interface may transport both digital signal information and control information for the transmitter, which may be multiplexed together through a single interface, as exemplified in the JC-61 RF-BB Interface standard.

8. Compliance with FCC rules will require appropriate certification tests and re-certification guidelines for all of the elements defined in a partitioned modular transmitter system, as clarified in the suggestions for paragraph 40 -- including the parts of the digital interface between front end and controller that can effect transmitter RF operation.

9. Thus, it is important that the rules include required certification tests on representative reference platforms that ensure that the modular components and interface operate in a compliant manner when integrated together in different product environments. They must operate at all times as a compliant system. We agree that the certification tests should include demonstrated compliance when the digital interface is subjected to maximum possible interfering noise of both normal and abnormal nature.

10. Methods of demonstrating compliance should include as a minimum: **a). injection of common mode noise between the local ground systems of the radio front end and the digital radio controller (normal operation)**; and **b.) injection of interfering pulses that cause the bit error rate of the digital interface to degrade substantially and in a random manner (representing abnormal operation).**

11. We note that digital interfaces will likely vary substantially in capability, with most interface implementations having typical bit error rates less than 10^{-12}. Test methods should be flexible enough to ensure a substantial degradation of error rate during the test (e.g. $>10^{-4}$) so that corruption events can be measured within standard RF spectral tests and with reasonably efficient test times.

12. For many envisioned partitioned modular radio systems, it will not be practical to directly measure interface bit error rate during radio operation or during a certification test. Therefore, we suggest limiting the test platform requirement to include means to inject random error pulses from an external source, by either direct analog coupling to the interface lines or by injecting them digitally within the digital radio controller. Either method will ensure that interface bit errors in the transmit control stream can be produced reliably during the test, without the necessity of directly measuring the error rate. One or both of these methods are believed to be more suitable alternatives to the methods mentioned in the current NPRM [e.g. a.) impulse interference testing similar to that in EN61000-4-4; and b.) using a two-tone interference test and coupling into the cabling.], since they ensure corruption of the interface for a wide range of possible digital interface designs.

13. For interference injection with direct analog coupling to the interface, the required interference levels will vary based on the type and design of the digital controller interface. We have included brief description with examples of suitable interference injection methods for a JEDEC JC-61 RF-BB type of interface in the attached Appendix B. This is for informational purposes and is not suggested for inclusion in the modified FCC rules.

14. Specific requirements and guidelines for "reference platform" compliance testing will be needed for final modifications to the Part 15 rules. Specifically, the interface interference testing method, parameters, and the impact on RF spectral measurement methods, number of tests required, and total test time -- all need careful consideration. We encourage the codification of additional requirements into Sec 15.212 for modular transmitters.

NPRM PARAGRAPH 40 STATES:

"Requirement #5. For the purpose of testing partitioned modules, we propose to define a "reference platform" that the radio manufacturer would build and submit for testing. At the minimum, a reference platform would consist of the radio front end, antenna, and an "environment" such as a PDA or laptop on which the firmware will operate. Any future changes to the radio front end or firmware would require re-testing on the pre-approved reference platform."

15. The text here should clarify the definition of 'reference platform' and 'firmware' in line with the concept of partitioning into a radio front-end and digital radio controller connected through a digital interface.

16. The 'reference platform' should include a full representative implementation of the intended radio components, interface, and firmware, and all representative instances of mix-and-match system components that would be tested and certified for FCC compliance.

17. A clear line should be drawn around the elements of hardware or firmware external to the radio module that impact transmit control and could in any way impact regulatory behavior of the transmitter unit. What is intended is that future changes to the front end module or any of the relevant external digital controller functions, including firmware changes, which impact the transmit control and could in any way impact regulatory behavior would require re-testing.

18. Some provision should exist for system changes that do not impact radio transmitter control functionality, including IC architecture and process changes in the digital controller and many types of non-consequent hardware or software changes that occur naturally in controller instantiations within a modern product life cycle. These should not require re-certification if, in the judgment of the OEM and radio component suppliers, they do not have impact on transmitter RF operation. We believe this philosophy is consistent with the current regulatory approach.

19. Finally, the "reference platform' should be fully equipped for required digital interface interference testing and for tests in all intended configurations and radio operating modes specified by the radio component suppliers and to be covered by the certification.

> With reference to the statements: *"The signal injection testing would be done on the implementation with a maximum length of cabling connecting the modular components. We seek suggestions regarding both the design of a reference platform and the length and type of cable used to connect the components."*

20. We note that the partitioned system model discussed so far may include any type of digital interface with signaling level above 150 mV peak-to-peak (presumed at the line receiver side of the interface). Depending on product application, such an interface may use a wide variety of physical interconnection schemes, as specified by radio component suppliers. It is not practical to specify a priori the length and type of cables for all implementations.

21. The reference platform used for testing should be representative of worst-case interface conditions. In particular, we suggest that maximum controller interface interconnect lengths be represented in the test platform, and that the platform be provisioned with inputs and

instructions to properly inject worst case common mode noise and interfering signals at the critical digital radio controller interface.

22. Further suggestions are contained in the JEDEC JC-61 interface examples provided in the attached Appendix B.

NPRM PARAGRAPH 41 STATES:

"In addition to the changes proposed above, we also propose to add a ninth requirement specific to partitioned modular transmitters to ensure that only a radio front end and firmware that have been certified together as a pair may operate with one another. This requirement will make certain that consumers or third parties do not mix and match radio front ends and firmware in combinations that may result in unauthorized operation. We propose to require that manufacturers implement a unique digital key or "Type Number" which allows approved radio front ends and firmware to recognize each other. We tentatively propose that the Type number will consist of a digital word 4 bytes in length with the following bit definition: 16 Bits for the Company information, 16 Bits for the Device Number. We seek comment on the practicality of implementing such a requirement."

23. This requirement is important to ensure the compatibility of certified modular radio configurations prior to operation. Similar comments to those given above for paragraph 38 apply to the use of the term "firmware" here. The digital radio controller should implement an interlock mechanism that checks the unique radio front-end identifier with the format suggested. The digital radio controller (with associated firmware) is responsible for verifying compatibility of the front-end module that is connected prior to operation.

24. We recommend that the "interlock" requirements be studied further before inclusion in the final FCC rules. A digital signature method may be appropriate, but is only one way of achieving the objective and may be too restrictive on digital radio controller implementations.

25. We urge the Commission to **adopt an industry standard scheme for device and type numbering**. The JC-61 committee has approved an industry wide standard for a digital interface between the radio front-end and digital radio controller. **The JC-61 standard defines a 4 byte value separated into a 2 byte manufacturer's JEDEC-assigned ID code and a 2 byte device type.**

26. The manufacturer's ID is a 16-bit value, derived from the manufacturer's JEDEC-assigned ID code listed in JEP 106[3] for the purpose of uniquely identifying the manufacturers of these devices. The low-order 8 bits are read from a fixed register with an unique address labeled 1A and the high-order 8 bits are read from another unique address labeled register 1B. Register 1A contains the last 8 bits of the manufacturer's ID value as listed in JEP 106. Register 1B

[3] The JEP-106 was initially published in August 1984 with 33 initial company members. So far JEDEC has issued 580 Manufacturer's Identification Codes which are included in 126 codes per banks. Requests for Manufacturer's Identification Code can be submitted via the JEDEC website. These codes do not expire.

contains the number of continuation fields that appear at the beginning of the manufacturer's ID value as listed in JEP 106.

27. The Device Type is a 2 byte value, assigned by the manufacturer identified in the MFG ID of this device, for the purpose of uniquely identifying the type of this device among the full set of all types of front-end devices produced by that manufacturer. The low-order 8 bits of this device type value are read from register labeled 1C and the high-order 8 bits are read from register labeled 1D.

28. It is preferable for register labels 1A, 1B, 1C, and 1D to have actual address of hexadecimal 0x1A, 0x1B, 0x1C, 0x1D, respectively.

29. The JC-61 Committee, a consortium of 43 member companies has been working on digital standards between a radio front-end and a digital radio controller since March 2002 and represents a large group of companies interested in the "partitioned module". The JEP-106 has been in existence for 20 years and has a listing of all the major companies in the industry. For new companies the issuance of a Manufacturing ID is a trivial process with at a nominal fee [4] and does not require JEDEC membership. We urge the Commission to adopt the above proposed device type coding for FCC type approval.

With respect to the statement: *"We encourage commenting parties to suggest appropriate methods for implementing this form of encryption."*

30. Since specific acceptable methods and requirements are to be determined, we suggest replacing the word "encryption" with "protection".

Respectfully submitted,

/s/
Ed Liu
Chairman, JC-61
January 22, 2004

[4] Current Fees is $200 (US)

APPENDIX A. PARTITIONED RADIO MODULE ARCHITECTURES

Background

31. There have been two distinct architectures emerging for implementing partitioned radio modules for WLAN. These architectures may have a potential impact on certification.

32. The first architecture shown in Figure A.1 is the conventional architecture based on a microcomputing subsystem (CPU, I/O logic, Program memory and Data memory) with an external flash memory. In this architecture the Flash memory contains what is traditionally called “firmware”. The firmware is program memory that upon power up is downloaded into program memory on chip. The microcomputing system implements the entire modem consisting of full Medium Access Control (MAC) and baseband digital signal processing. By changing the firmware most characteristics of the modem can be modified.

33. The second architecture shown in Figure A.2 has recently emerged and is not based on a microcomputing subsystem but rather hardwired logic and programmable registers. The logic and registers implement only the Lower MAC and the baseband digital signal processing. The remaining portion of the full MAC function, called the Upper MAC, is executed on the Host Processor from the driver software. At a high level, the Lower MAC executes per packet functions while the Upper MAC executes per session functions. The lower MAC and baseband signal processor are controlled by writing the registers. There is no traditional ‘firmware’.

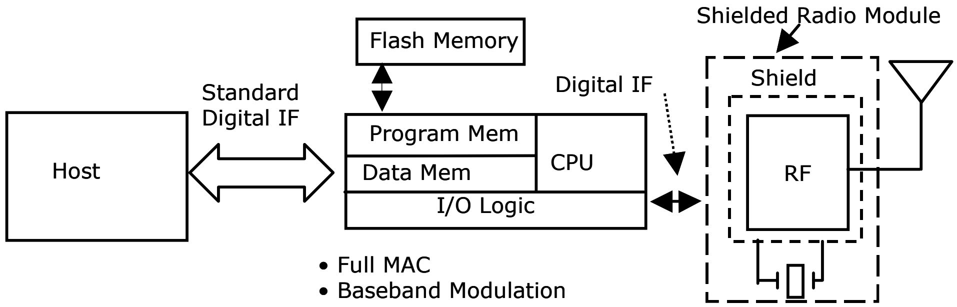

Figure A.1

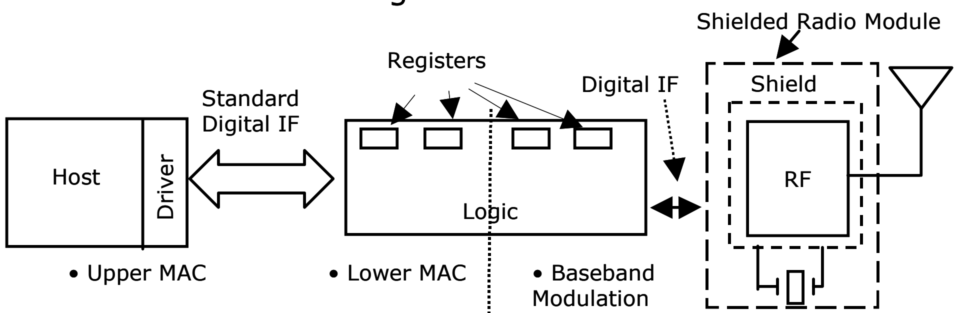

Figure A.2

Potential Impact on Certification

34. The existing rules basically govern the first architecture with the exception of the changes related to the NPRM.

35. The second architecture is more deterministic from a certification viewpoint. The registers will hold values that control functions such as modulation type, transmit power, country codes and channel selection. The values that can be programmed into the registers are finite and therefore the worst case combinations can be tested and measured. This being the case certification testing should be virtually independent of the driver revision; new revisions of the driver should not result in re-certification. In this sense certification compliance of products implemented using the second architecture is less likely to change over time.

APPENDIX B. DIGITAL INTERFACE INTERFERENCE TESTING METHODS FOR A MODULAR RADIO WITH JEDEC JC-61 RF-BB INTERFACE

Background

36. The block diagram of Figure B 1 shows a modular Wireless LAN radio system partitioned as an RF front end transceiver module (FED) connected to a digital radio controller backend device (BED). The FED and BED are connected through a JC-61 RF-BB Interface. The JC-61 RF-BB interface is a high-speed differential serial data interface comprised with 3 differential signal pairs: clock from FED to BED; Rx Data from FED to BED; and Tx Data from BED to FED. In this configuration, digital signal and control data to the FED transmitter are multiplexed over the TxD pair.

37. The 6-wire serial interface is electrically similar to standard serial computer I/O interfaces such as HyperTransport.

38. Serial data rates on the TxD interface can range from about 400 Mbps to over 1.6 Gbps during packet transmission in the WLAN radio module. The length of the digital interface may be up to 1 meter. However, a wide range of lengths may be utilized in products, some involving only very short point-to-point IC interconnections.

39. For FCC certification testing of such a modular system, a reference platform would be provided with representative maximum distance interconnect loading, and with provisions to inject normal and abnormal interfering signals into the interface from standard external test equipment.

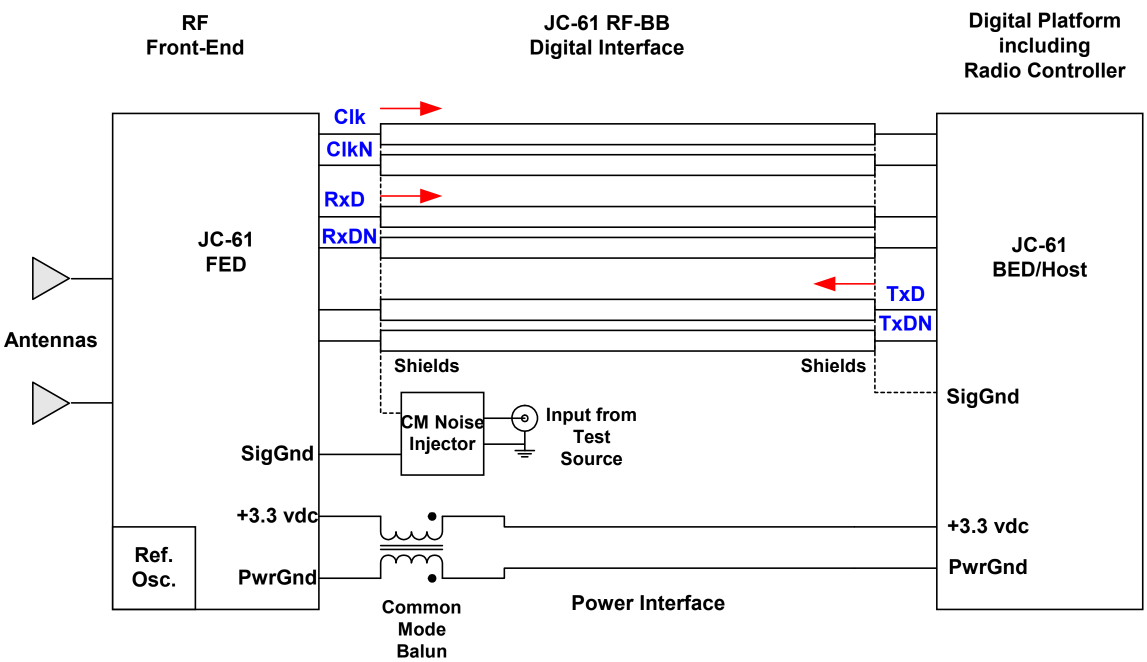

Figure B 1: Modular Radio System with JC-61 RF-BB Digital Interface

Common Mode Noise Injection Test Method

40. Figure B 1 also shows a method for coupling a broadband common mode noise interference into a test reference platform with this type of interface. It is assumed that the reference platform has provisions to isolate the common grounds for the FED section and BED sections of the platform, allowing a common mode offset to be introduced at the line receiver side of the TxData interface. The digital interface interconnect may be in the form of controlled impedance PCB traces or one of several types of transmission line cables.

41. A common mode balun is inserted into the power supply lines in order to isolate the supply impedance from the common mode difference of the two sides. A CM injection circuit is connected between the normal signal ground of the RF front-end and the return shields of the interface interconnect, on the RF module side. This allows a relatively broadband common mode noise interference signal to be injected at the TxData receiver input from a 50 ohm test signal generator.

42. The JC-61 RF-BB Interface is specified to operate with up to 200 mV peak-to-peak common mode noise, with spectral energy distributed anywhere in the DC to 200 MHz region. For this example, an appropriate CM interference test might use one of two different test signals, injected as shown with 1) 200 mV peak-to-peak CW swept between 1 MHz and 200

MHz; or 2) 40 mV rms random noise with uniform spectrum between 1MHz and 200MHz as shown in Figure B2.

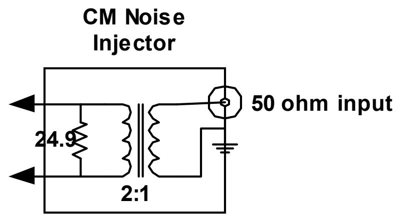

Figure B2: CM Noise Injector

43. This example is meant for informational purposes only. Specific test requirements and parameters are not meant to be indicated here, only an appropriate platform injection method.

44. The common mode noise injection tests simulate a worst case implementation environment as a bound for all likely product implementations with the modular radio components. Certified modular components may be implemented in a variety of different product packages. Common mode ground noise is a normal part of any packaging where there is significant interface distance between the RF front end module and the digital radio controller. This test is for robustness of the RF transmitter behavior relative to various package implementations.

Pulsed Interference Injection Test Methods

45. The pulse interference tests suggested in comments for paragraph 38 are intended to measure the RF transmitter behavior in the presence of abnormal occurrences strong pulsed noise on the digital interface that cause bit errors.

46. The examples below suggest two possible ways to introduce the bit errors from an external test source: 1.) **direct digital injection into the bitstream within the digital radio controller**, and 2.) **direct analog coupling of error pulses into the digital radio controller TxData driver interface.**

47. The first method is illustrated in Figure B3. Here, a digital test port is provided in the digital radio controller logic in order to allow externally input data to be Ex-or'd into the digital stream during a certification test. The provision may be part of the test capability of the digital radio controller IC or otherwise somehow implemented in the reference platform. Whenever the test port input is asserted, the normal transmit data polarity is inverted in real time, causing bit errors in the TxData stream. The error pulses may be implemented from an external generator

that is producing narrow digital pulses by random or pseudo-random triggering. The injected bit error rate can be regulated by the triggering frequency and pulse-width of the test source.

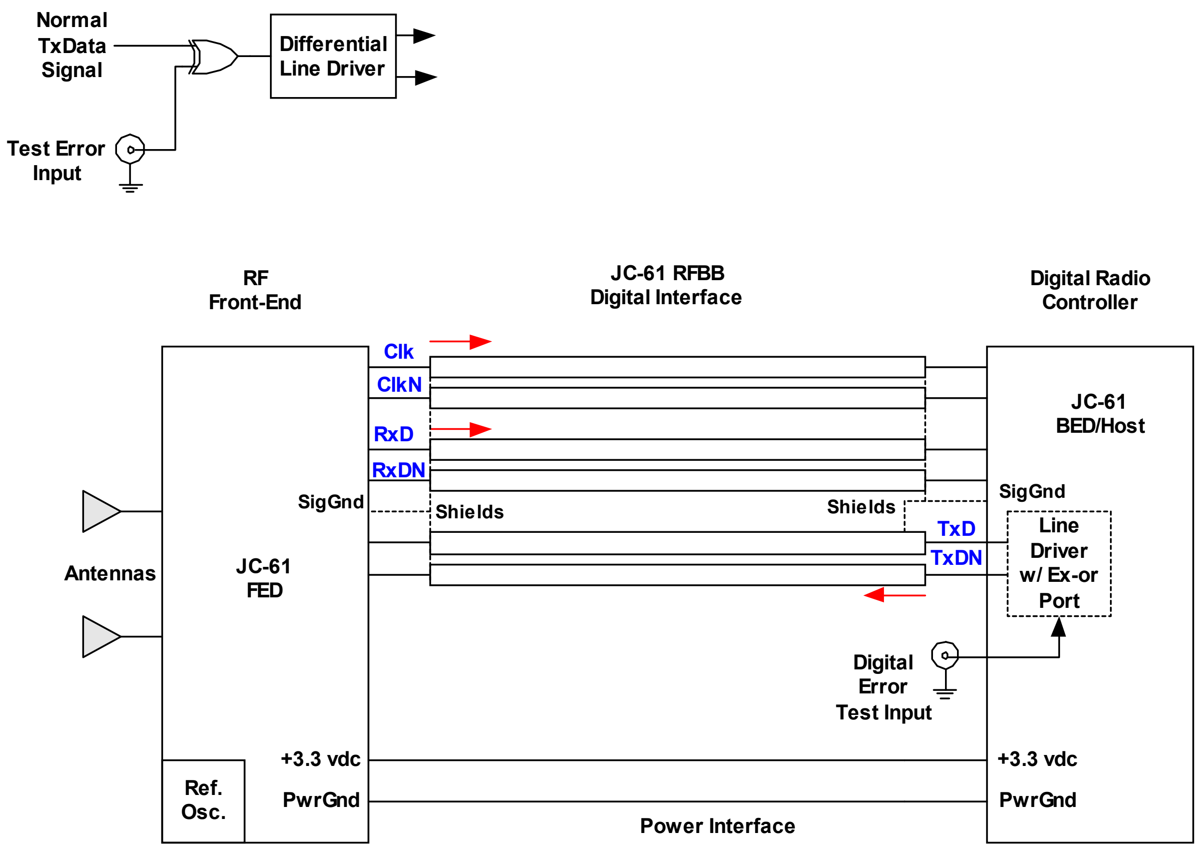

Figure B3: Line Driver with Exor'd Test Input Port

48. The second method is illustrated in Figure B4. This method involves direct coupling of an analog error pulse source on the transmitter side of the TxData interface pair.

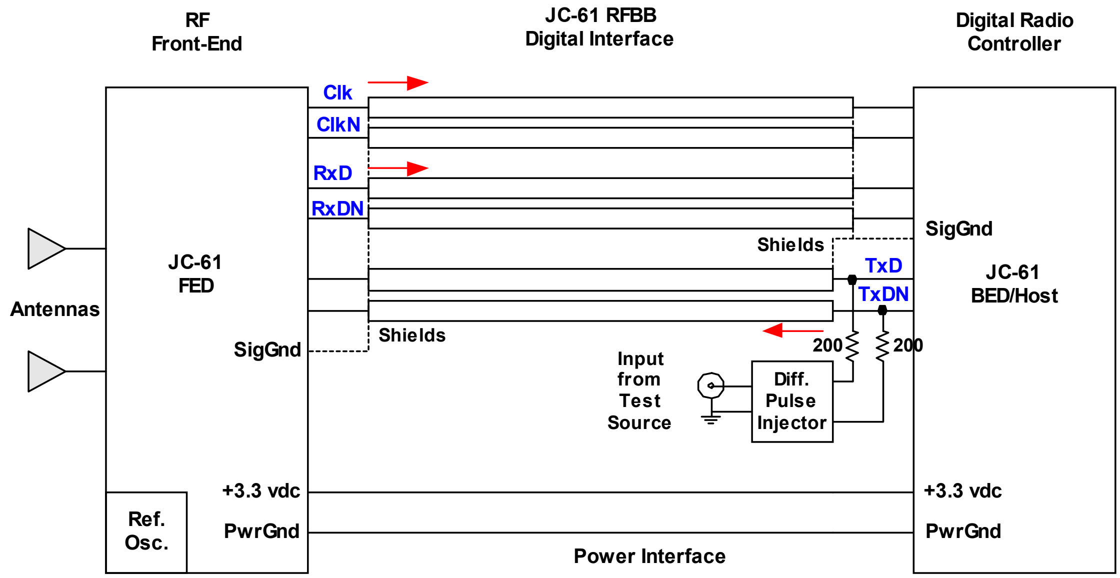

Figure B4: Analog Method for Injection of Interface Error Pulses

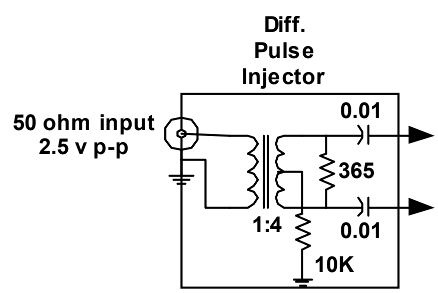

Figure B5: Example Differential Pulse Injector Circuit

49. This example assumes a 100 ohm differential termination impedance for the TxData differential line driver/receiver. The transformer circuit of Figure B5 generates large differential pulses that override the normal driver output amplitudes of the JC-61 differential interface. The relatively high source impedance of this injector circuit ensures negligible disturbance of the normal operating impedances and voltages of the doubly terminated JC-61 transmission line interface.

50. Both the digital and analog error pulse injection methods would use a similar external 50 ohm test signal source. For example, the interference test source might consist of a pulse generator producing narrow pulses (e.g. 5 ns to 10 ns) and triggered from a PRN sequence generator running at a lower rate (e.g. 20 MHz). This would generate error pulses with pseudo-random spacing on 50 ns centers at a frequency unrelated to the digital interface clock.

51. These examples are meant for informational purposes only. Specific test requirements and parameters are not meant to be suggested here, only an example methodology. It is

assumed that the appropriate signal injection method and parameters would be provided in the reference platform design submitted for FCC certification testing.

[5] The JEP-106 was initially published in August 1984 with 33 initial company members. So far JEDEC has issued 580 Manufacturer's Identification Codes which are included in 126 codes per banks. Requests for Manufacturer's Identification Code can be submitted via the JEDEC website. These codes do not expire.

[6] Current Fees is $200 (US)